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Journal of the Egyptian Society of Cardio-Thoracic Surgery 24 (2016) 238–248

http://www.journals.elsevier.com/journal-of-the-egyptian-society-of-cardio-thoracic-surgery/

Original article

Management plan for deep sternal wound infection targeting to survival free of recurrence: A prospective evaluation study

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Available online 31 August 2016

Abstract

Objective: To evaluate outcome of modalities for management of deep sternal wound infection (DSWI) defined as peri-procedural mortality and to determine the predictors for this outcome.

Patients & Methods: Management plan was controlled by the findings after sternal wound debridement till the patient was bacteriologically negative. This plan ranged between simple rewiring of sternal remnants, if appropriate, rewiring and bilateral pectoralis major advancement flap (PMF) coverage, vascularized omental flap (VOF) or PMF coverage without rewiring if sternal remnants were inappropriate and combined VOF and PMF coverage in case of wide sternal defect and/or absence of any trustable sternal remnants.

Results: Throughout the study duration 121 out of 7850 patients underwent sternotomy for open cardiac surgery developed DSWI for a frequency of 1.54%. Nineteen patients died for a total mortality rate of 15.7%, 9 patients developed complications for a morbidity rate of 7.4% and 93 patients passed their postoperative (PO) course uneventfully for a total success rate of 76.9%. PMF and VOF showed success rates of 94.7% and 81.8%, respectively. Wiring only and wiring followed by PMF showed success rates of 78.6% and 75%, respectively. Combined VOF and PMF showed a success rate of 72.2% for selected cases with wide sternal wound. Number of risk factors/patient was significantly higher in non-survivors than in survivors. Obesity and multiplicity of risk factors were the most significant predictors for mortality. Individually obesity and diabetes mellitus were the significant predictors for mortality.

Conclusion: Management of DSWI is tedious, has prolonged hospital stay and is associated with high morbidity and mortality rates. Management of DSWI must be personalized according to findings on exploration of the sternal wound and flap coverage must be initiated only when the patient is bacteriologically free. Both PMF and/or VOF provided high acceptable success rate defined as survival free of DSWI recurrence.

Keywords: Chest wall; Deep sternal wound infection; Rewiring; Muscle flap; Omental flap

List of abbreviations: DSWI, Deep sternal wound infection; ITA, Internal thoracic artery; PMF, Pectoralis major advancement flap; PO, Postoperative; VOF, vascularized omental flap; BMI, Body mass index; VAC, Vacuum-assisted closure.

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Peer review under responsibility of The Egyptian Society of Cardio-thoracic Surgery.

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http://dx.doi.org/10.1016/j.jescts.2016.04.001

1. Introduction

The blood supply of the sternum plays a major role in healing of the sternum after sternotomy. Sternal blood supply is derived mainly from the medial horizontal branches of the internal thoracic artery (ITA) [1]. The ITA is the conduit of choice in coronary bypass grafting, due to the excellent long-term results achieved using it. However, increased incidence of sternal infections after pedicled ITA harvesting is still a problem and one of devastating complication of sternotomy [2].

The ITA is usually described as giving off sternal, anterior intercostal and perforating branches supplying their respective areas. For these branches to function as collaterals after ITA harvesting, the common trunk of origin must remain intact; so it must be ligated as close as possible to the ITA to maintain collateral blood flow to the sternum intact [3].

DSWSI is the major infectious complication in patients undergoing cardiac surgery, associated with a high morbidity and mortality rate, and a longer hospital stay. The most common causative pathogen involved is Staphylococcus spp. The management of post-sternotomy mediastinitis associates surgical revision and antimicrobial therapy with bactericidal activity in blood, soft tissues, and the sternum [4].

Multiple trials were conducted to prevent or minimize DSWI however, the outcome is unsatisfactory where Ozdemir & Aykut [5] found bone wax application does not reduce bleeding on sternal sides with no evidence that application of bone wax causes or prevent DWSI in patients having median sternotomy for coronary bypass surgery. Also, Kowalewski et al. [6] found implantable gentamicin-collagen sponges significantly reduce the risk of sternal wound infection after cardiac surgery, but the extent of this benefit might be attenuated in patients receiving bilateral ITA grafts. Moreover, Srivastava et al. [7] reported that thermoreactive clips did not have an advantage in the prevention of superficial or DSWI in obese patients undergoing sternotomy.

These data indicated the necessity of meticulous management policies for cases developed DSWI. Thus, the current prospective study aimed to evaluate the outcome of various modalities for management of DSWI defined as periprocedural mortality and to determine the predictors for this outcome.

2. Patients & Methods

The current multi-center study was conducted at Cardiothoracic Departments at Benha and Suez Canal University Hospitals and in Nasr Institute since April 2008 till Sep 2015. The study protocol was approved by the Local Ethical Committees in participating hospitals. The study intended to include patients developed DSWI secondary to median sternotomy for open cardiac surgical procedures. Only patients signed written fully informed consent were included in the study.

DSWI was defined as osteomyelitis and retrosternal space involvement and was diagnosed on fulfilling at least one of the criteria defined by the Centers for Disease Control and Prevention (CDC) for mediastinitis. Mediastinitis must meet at least one of the following signs or symptoms with no other recognized cause: fever (>38 °C), chest pain or sternal instability and purulent discharge from mediastinal area, organisms cultured from blood or discharge from mediastinal area, and/or mediastinal widening on X-ray. Osteomyelitis must meet at least two of the following criteria: localized swelling, tenderness, heat or drainage at suspected site of bone infection and at least one of the following: organisms cultured from blood, positive blood antigen test and radiographic evidence of infection e.g. abnormal findings on X-ray, CT scan, and MRI [8].

Collected patients' data included age, gender, body mass index (BMI) data, the indication for the primary cardiac surgery, presence of additional medical co-morbidities or risk factors and time lapsed since primary cardiac surgery till development of manifestations of DSWI and time required to get clean bacteriologically negative wound to allow success of grafting process.

2.1. Management plan

After obtaining blood and discharge samples, intravenous antibiotic therapy covering Gram-positive and anaerobic bacteria was started until results of culture and sensitivity test were available. Skin incision was opened and the infected tissues, including bone and cartilage, were debrided under local or general anesthesia. After 48-hr if laboratory, radiological, and clinical findings did not improve and the patient failed to respond to treatment, the wires were removed under general anesthesia and wound irrigation with normal saline and intravenous antibiotic therapy was

continued till patient was improved or further debridement was performed. Operative interference was conducted only after complete open drainage of the wound, omission of any loculated area of infection and patients were bacteriologically negative.

Operative indications included impossible wire restabilization of the sternum, failure of conservative therapy or succeeded conservative therapy and restabilization but flap coverage is required.

Operative procedures included rewiring either alone or covered by bilateral PMF for cases with sternal remnants sufficient for rewiring. If the sternal defect was not large but sternal remnant are inadequate for rewiring, either VOF or PMF was conducted and the sternum was not rewired. In case of large sternal defect, complete sternotomy was performed or if no sternal remnant was present, VOF was conducted and covered by bilateral PMF. Skin and subcutaneous tissues were primarily closed over the flap without the need for skin grafting if possible otherwise a vacuum-assisted closure (VAC) device was applied.

2.2. Operative procedures

1. Omental flap

An upper midline abdominal incision was made from the previous sternotomy wound to the upper part of the abdomen. An omental pedicle was fully mobilized on the gastroepiploic artery by dividing the branches to the greater curvature of the stomach and mobilized off the transverse colon. Without size reduction, the omental flap was passed through an appropriate small-size tunnel created at the anterior part of the diaphragm to cover the entire surface of the exposed cardiovascular structures in the mediastinum with great care to avoid torsion and to prevent strangulation. The omental flap was tacked with a few tension-free compass sutures to the mediastinal site at the diaphragm and the suprasternal end of the wound. Fig. 1.

2. Pectoralis major advancement flap

Costal and sternal origins of pectoralis major were dissected and released. The inferior and lateral borders were then cut and dissected upwards towards humoral insertion, and then the free pectoral muscle was rotated to the midline along the axis of its insertion tendon to maintain normal muscle function. Pectoral neurovascular bundles were dissected meticulously to maintain nerve and blood supply to the muscle. Dissection must allow the muscle to cross the midline to be attached to the pectoral fascia of the contralateral side in case of unilateral flap or to crisscross with the contralateral pectoralis major to overlap the defect by both muscles. The choice of unilateral or bilateral pectoral muscle turnover flaps was based on the extent of the sternal defect. Fig. 2.

2.3. Postoperative care

All patients were managed in ICU and were transferred to the surgical ward after stabilization of general condition. Postoperative hospital stay and duration required for assurance of sternal wound closure without recurrence of

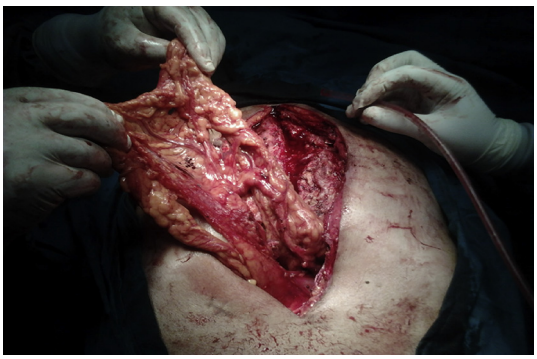

Fig. 1. Management of sternal wound infection using vascularized omental flap (VOF).

Fig. 2. After rewiring and bilateral advancement pectoral muscle flap.

infection or development of other complications were determined. Procedural success was defined as survival free of DSWI recurrence during follow-up period. Mortality rate included pre-procedural mortality rate, i.e. mortality occurring during wound preparation and post-procedural mortality rate, i.e. mortality occurring after completion of the procedure.

2.4. Statistical analysis

Obtained data were presented as mean ± SD, ranges, numbers and ratios. Results were analyzed using One-way ANOVA with post-hoc Tukey HSD Test and Chi-square test (X^2 test). Preoperative risk factors were evaluated as predictors for postoperative mortality using the receiver operating characteristic (ROC) curve analysis judged by the area under the curve (AUC) compared versus the null hypothesis that AUC = 0.05. Statistical analysis was conducted using the SPSS (Version 15, 2006) for Windows statistical package. P value < 0.05 was considered statistically significant.

3. Results

Throughout the study period 7850 patients underwent open cardiac surgery; 4900 males (62.4%) and 2950 females (37.6%) for varied indications. Only 121 patients developed manifestations that fulfilled the perquisite criteria for diagnosis of DSWI for a frequency of 1.54%. Among patients developed DSWI; 73 patients were males for a frequency of 1.49% among total male patients had open cardiac surgery and 48 patients were females for a frequency of 1.63% among total female patients had open cardiac surgery. Mean age of patients developed DSWI was 61.5± 8.2; range: 46–78 years and their mean BMI was 30.3 ± 4.1; range: 23.2–39.2 kg/m^2. Mean time till development of DSWI after the primary open cardiac surgery was 8.2 ± 3.5; range: 3–16 days and mean lapsed till definitive management of DSWI was 5.8 ± 1.3; 3–8 days. The most common organism was coagulase positive cocci. Details of enrollment data are shown in Table 1.

Unfortunately, 5 patients died secondary to severe sepsis in addition to uncontrolled medical conditions for a pre-procedural mortality rate of 4.1%. Twenty-two patients (19%) underwent successful rewiring; 14 patients did not require additional procedure, while 8 patients required pectoralis major flap (PMF) for coverage of wired weak sternal wound. Two patients died 3 and 5 days after rewiring, because of acute respiratory failure and diabetic hyperosmolar ketoacidosis and failed to respond to medical treatment. Two of patients had re-wiring only developed partial sloughing of newly inserted wires that required drainage without removal of wires and were prepared for PMF that was conducted successfully and patients were discharged uneventfully.

Rewiring was impossible in 71 patients (58.7%) and underwent flap wound closure; 38 patients underwent PMF and 33 patients underwent VOF. Eight patients had recurrent sternal defect secondary to infected flap that was partially released for wound drainage; unfortunately, five patients developed septicemia and died, while the other three responded to medical treatment and debridement and then VAC device was applied for defect closure and patients completed their postoperative (PO) course and were discharged uneventfully. The remaining 63 patients completed their PO course uneventfully and were discharged without complications.

The remaining 23 patients required frequent debridement of the sternal wound and continuous wound irrigation by antibiotics and povidone-iodine, unfortunately sternal remnants were too defective and weak to withstand rewiring trial. During wound preparation two diabetic patients failed to respond and sepsis progressed to septic shock and both died prior flap wound closure. Two patients showed clinical manifestations of pulmonary embolic disease mostly secondary to having septic showers and a third patient developed acute myocardial infarction; the three patients died. The remaining 18 patients underwent flap-wound closure using combined VOF and PMF. During PO course of these

Table 1
Data of DSWI patients.

Data				Findings
Frequency	Total patients			7850
	DSWI	Number (patients)		121
		Frequency among total cases		1.54%
Gender	Males	Frequency among total patients		4900 (62.4%)
		Frequency among DSWI		73 (1.49%)
	Females	Frequency among total patients		2950 (37.6%)
		Frequency among DSWI		48 (1.63)
Age (years)		Strata	<50	13 (10.7%)
			50–60	50 (41.3%)
			>60–70	32 (26.4%)
			>70	26 (21.6%)
		Total		61.5 ± 8.2
BMI data	Weight (kg)			87.5 ± 12.3
	Height (cm)			169.9 ± 3.6
	BMI (kg/m^2)	Strata	Normal	13 (10.7%)
			Overweight	68 (56.2%)
			Obese	26 (21.4%)
			Morbid obese	14 (11.7%)
		Total		30.3 ± 4.1
Type of previous surgery		Only CABG surgery		64 (52.8%)
		CABG & other cardiac surgery		10 (8.3%)
		Valve replacement surgery		30 (24.8%)
		Surgery for congenital heart disease		15 (12.4%)
		Cardiac trauma		2 (1.7%)
Time lapsed between primary surgery and development of DSWI (days)			≤7	26 (21.5%)
			8–13	66 (54.5%)
			≥14	29 (24%)
			Mean (±SD) time	10.7 ± 3.3 [6–18]
Time lapsed till definitive surgery (days)			4–5	52 (43%)
			6–7	57 (47.1%)
			>7	12 (9.9%)
			Mean (±SD) time	5.8 ± 1.3 [4–8]

Data are shown in mean ± SD & numbers; percentages & ranges are in parenthesis.

patients, one patient had an attack of acute myocardial infarction and died. Four patients developed partial wound infection that responded to wound cleaning and VAC device was applied.

At the end of the study, 19 patients died for a mortality rate of 15.7%, while 9 patients developed post-procedural complications for a morbidity rate of 7.4%. The remaining 93 patients passed their PO course uneventfully for a total success rate of 76.9% (Table 2).

As regards procedural outcome; wiring only showed a success rate of 78.6%, a morbidity rate of 14.3% and mortality rate of 7.1%. Wiring and PMF showed a success rate of 75% and a morbidity rate of 25%, but no mortality. VOF showed a success rate of 81.8%, a morbidity rate of 9.1% and mortality rate of 9.1%. PMF showed a success rate of 94.7%, a mortality rate of 5.3%. Combined PMF & VOF showed a success rate of 72.2%, a morbidity rate of 22.2% and a mortality rate of 5.6% (Fig. 3).

Six patients developed septic shock and died because of multiple organ failure (MOF), another 6 patients developed septicemia secondary to uncontrolled diabetes mellitus (DM) and failed to respond to intensive insulin therapy and died. Another two diabetic patients developed ketoacidosis, the first had hyperosmolar and the second had hyperglycemic, but both failed to respond to medical therapy and died. Two patients developed intractable pulmonary embolism and died immediately. Another two mortality case occurred secondary to acute myocardial infarction. The 19th patient had chronic obstructive pulmonary disease (COPD) progressed to acute respiratory failure (Fig. 4).

Evaluation of clinical data of DSWI patients categorized according to survival showed the following: non-survivors were significantly older than survivors with non-significantly higher number of females among non-survivors. Also, non-survivors had non-significantly higher BMI than survivors. As regards risk factors, the frequency of patients had risk factors in general and the frequency of risk factors was significantly higher in non-survivors than in survivors. Number of preoperative risk factors/patient was significantly higher in non-survivors compared to survivors. The frequency of obesity, DM, COPD, HR and CRF was significantly higher in non-survivors compared to survivors. Moreover, time lapsed between primary cardiac surgery and development of DSWI was significantly longer in survivors than non-survivors. On contrary, time lapsed till definitive surgery was significantly shorter in survivors than in non-survivors (Table 3).

ROC curve analysis defined multiplicity of risk factors and obesity as the most significant predictors for mortality, followed by old age and simply presence of risk factors (Table 4, Fig. 5).

Concerning the individual risk factors as predictors for mortality, ROC curve analysis defined presence of diabetes mellitus as the significant predictor for mortality, while the remaining co-morbidities were non-significant predictors for mortality (Table 5, Fig. 6).

4. Discussion

Throughout the study duration 121 out of 7850 patients underwent sternotomy for open cardiac surgery developed DSWI for a frequency of 1.54%. Despite the discrepant incidence of DSWI in literature; 0.6% [9], 2.5% [10] and between 0.5 and 4% [11], the frequency reported by the current study was in line with these figures and coincided with Colombier et al. [12] who reported an incidence of DSWI of 1.56%.

The current management plan was controlled by the findings after sternal wound debridement till patient was bacteriologically negative and ranged between simple rewiring of sternal remnants, if appropriate, rewiring and PMF

Table 2
Patients' distribution according to untaken procedures and its outcome.

Items		Died	Complicated	Cured	Total
Pre-procedure		5 (4.1%)	0	0	5 (4.1%)
Successful rewiring	Only	1 (0.8%)	2 (1.7%)	11 (9.1%)	14 (11.6%)
	Rewiring & PMF	2 (1.7%)	0	6 (5%)	8 (6.6%)
Impossible rewiring	VOF	3 (2.5%)	3 (2.5%)	27 (22.3%)	33 (27.3%)
	PMF	2 (1.7%)	0	36 (29.8%)	38 (31.4%)
Resistant DSWI	Prior to flap closure	5 (4.1%)	0	0	5 (4.1%)
	Combined PMF & VOF	1 (0.8%)	4 (3.4%)	13 (10.7%)	18 (14.9%)
Total		19 (15.7%)	9 (7.4%)	93 (76.9%)	121 (100%)

Data are shown in numbers; percentages are in parenthesis.

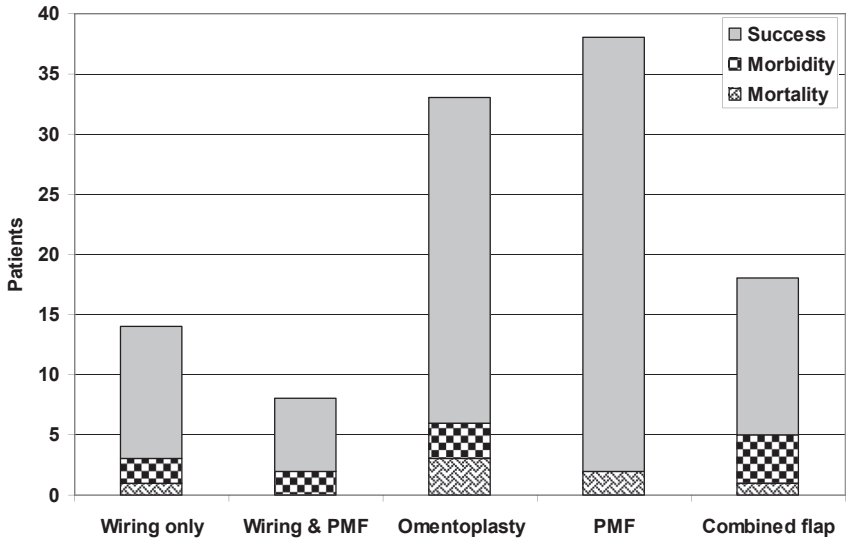

Fig. 3. Patients' distribution according to outcome of applied procedure for management of DSWI.

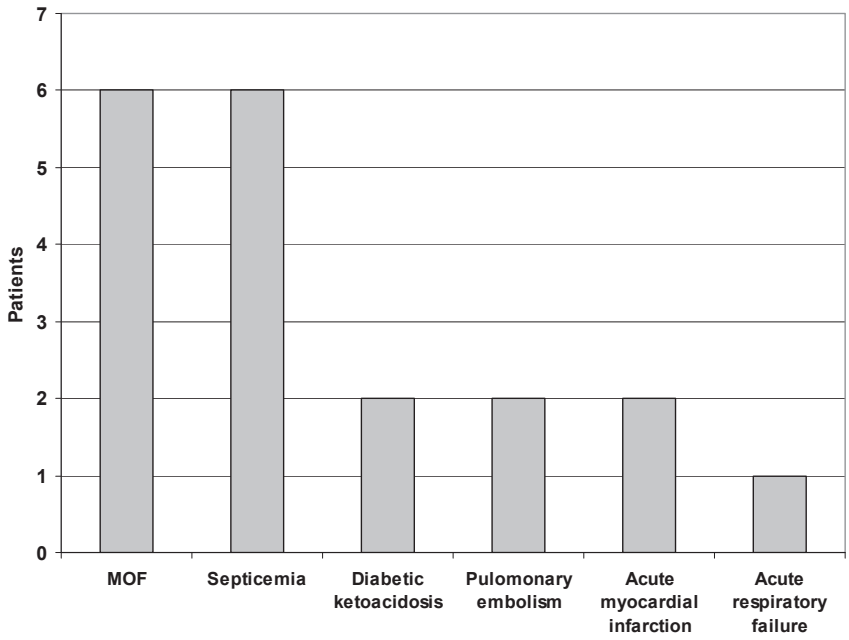

Fig. 4. Diagnosis and underlying pathogenesis for mortality cases.

coverage, VOF or PMF coverage without rewiring if sternal remnants were inappropriate and combined VOF and PMF coverage in case of wide sternal defect and/or absence of any trustable sternal remnants.

Such management plan goes in hand with Berg & Jaakkola [13] who presented the management of 60 consecutive DSWI; 57 patients were rewired and 3 patients had sternectomy, unilateral PMF was the choice for sternal wound closure in 50 patients, latissimus dorsi flap in 5 patients and rectus abdominis flap alone in 4 patients and in combination with PMF in one and 33 patients recovered totally uneventfully, while 27 patients developed complications including partial flap necrosis that required redo reconstruction in 3 patients.

Also, the current management plan was in line with Akil et al. [14] who recently documented that treatment strategy for DSWI consists of several steps including radical wound debridement with opening of all abscesses,

Table 3
Clinical data of DSWI patients.

			Survivors (n = 102)	Non-survivors (n = 19)	P value
Age (years)			60.6 ± 8	66.3 ± 7.8	0.0054
Gender; M:F			65:37	8:11	0.077
BMI			29.5 ± 1.6	29.5 ± 3.6	0.381
Risk factors	Frequency		44.1%	100%	0.0003
	Frequency of multiple risk factors	4 risk factors	1 (1%)	3 (15.8%)	0.00056
		3 risk factors	10 (9.8%)	5 (31.6%)	
		2 risk factors	15 (14.7%)	8 (36.8%)	
		One risk factor	38 (37.3%)	3 (15.8%)	
		No risk factors	58 (37.2%)	0	
	Type of risk factor	Obesity	29 (28.4%)	11 (57.9%)	
		DM	23 (31.5%)	16 (84.2%)	0.0008
		Hypertension	33 (45.2%)	8 (42.1%)	
		COPD	12 (16.4%)	5 (26.3%)	
		CRF	3 (4.1%)	3 (15.8%)	
		HF	2 (2.7%)	3 (15.8%)	
		Number of risk factors/patient	1	2.42	0.001
Time lapsed between primary surgery and development of DSWI (days)			11 ± 3.4	9.2 ± 3.8	0.036
Time lapsed till definitive surgery (days)			5.6 ± 1.3	6.8 ± 1.2	0.001

Data are shown in mean ± SD & numbers; percentages & ranges are in parenthesis.

Table 4
Predictors for mortality of DSWI.

Predictor	AUC	Std error	P value	CI
Old age	0.712	0.060	0.003	0.594–0.830
Male gender	0.392	0.071	0.136	0.252–0.532
Presence of risk factors	0.700	0.060	0.006	0.583–0.818
Multiplicity of risk factors	0.775	0.062	0.0008	0.655–0.897
BMI	0.761	0.057	0.0008	0.649–0.872

AUC: Area under curve; Std Error: Standard error; CI: Confidence interval.

resection of non-vital bone and removal of all infected allomaterial. Secondary wound closure was only planned after the infection is completely controlled through mobilization of both pectoral muscles together with the precostal soft tissues and for complicated or large defects various muscle flaps and the omentum majus have been advocated.

Irrespective of the applied procedure; at the end of the study, 19 patients died for a total mortality rate of 15.7%, while 9 patients developed post-procedural complications for a morbidity rate of 7.4%. The remaining 93 patients passed their PO course uneventfully for a total success rate of 76.9%. PMF used as a primary definitive therapy and as secondary management for complicated cases managed by another line of management showed success rate of 94.7%. VOF provided success rate of 81.8%, while wiring only and wiring followed by PMF showed success rates of 78.6% and 75%, respectively. Combined VOF and PMF showed a success rate of 72.2% for selected cases with wide sternal wound.

In line with these outcomes, Kobayashi et al. [15] reported that aggressive sternal debridement followed by VAC therapy and secondary closure with an omental-muscle flap is effective for DWSI and resulted in a lower incidence of recurrent infection, shorter hospitalization and did not greatly compromise long-term quality of life. De Brabandere et al. [16] documented that negative-pressure wound therapy-in combination with omentoplasty and bilateral pectoral advancement flaps is a valuable technique in the treatment of DSWI because it produces good functional and aesthetic results.

Recently, in 2015, Vaziri et al. [17] retrospectively evaluated the results of reconstructing DWSI with pedicled omentoplasty and reported intraoperative and PO complications rates of 7.5 and 25%, respectively. Bagheri et al. [11] prospectively, in their series of PMF reconstruction for management of DWSI, reported complete remission of DSWI with no recurrence during follow-up period in 75.7%, but 12.1% of patients needed reoperation and 4 patients (12.1%) died; three due to PO respiratory failure and one due to pulmonary thromboembolism.

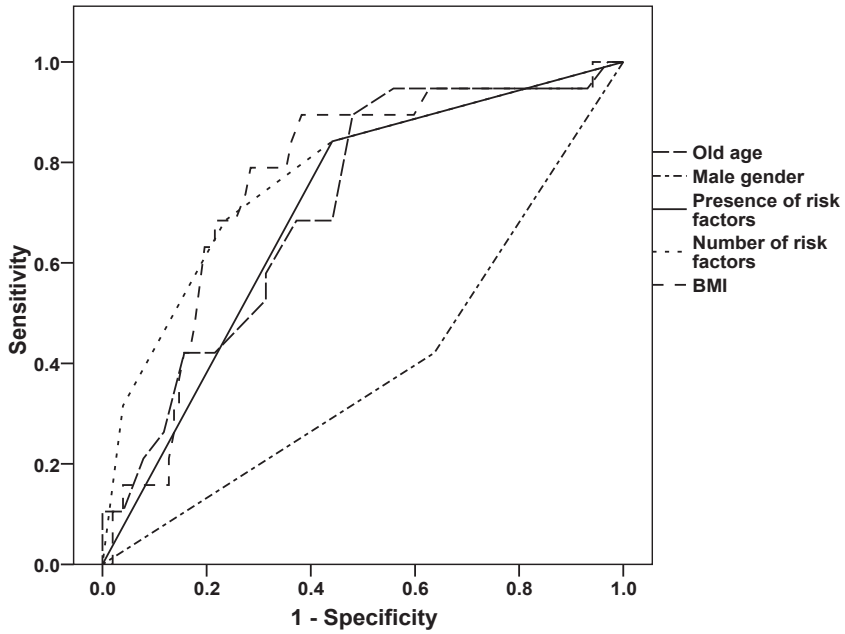

Fig. 5. ROC curve analysis of risk factors as predictors for mortality of DSWI patients.

Number of preoperative risk factors/patient was significantly higher in non-survivors than in survivors. Statistical analysis defined obesity and multiplicity of risk factors as the most significant predictors for mortality. Concerning individual risk factors, ROC curve analysis defined presence of diabetes mellitus (DM) as the significant predictor for mortality.

In line with these findings, Colombier et al. [12] reported that significant independent predictive factors for DSWI were active smoking, obesity, and DM. van Wingerden et al. [18] reported that among their series of six patients with DSWI considerable preoperative risk factors were present: one patient suffered from severe and two from moderate COPD, three from DM and three were on glucocorticoid steroid therapy preoperatively for a mean frequency of risk factor of 1.5/patient.

Lepelletier et al. [4] documented that prevention strategies for DSWI include controlling patient's risk factors, namely DM, obesity, respiratory insufficiency; preparing the patient's skin, antimicrobial prophylaxis, environmental control of the operating room and medical devices, indications and adequacy of surgical techniques. Yumun et al. [19] reported that significant risk factors for mortality after DWSI were additional operation, DM, and a high level of EuroSCORE.

Gatti et al. [20] found female gender, obesity; DM, poor glycemic control, chronic lung disease and urgent surgical priority were the predictors of DSWI which complicates routine bilateral internal thoracic artery grafting for

Table 5
Risk factors as predictors for mortality of DSWI patients.

	AUC	Std error	P value	CI
Diabetes mellitus	0.807	0.054	0.0007	0.700–0.914
Hypertension	0.562	0.073	0.472	0.408–0.696
Chronic obstructive pulmonary disease	0.577	0.076	0.287	0.428–0.727
Chronic renal failure	0.564	0.077	0.377	0.413–0.715
Heart failure	0.569	0.077	0.341	0.418–0.720
Obesity	0.974	0.030	0.0004	0.915–1.032
Time lapsed between primary surgery and development of DSWI	0.318	0.076	0.012	0.170–0.466
Time lapsed till definitive surgery	0.751	0.062	0.001	0.631–0.872

AUC: Area under curve; Std Error: Standard error; CI: Confidence interval.

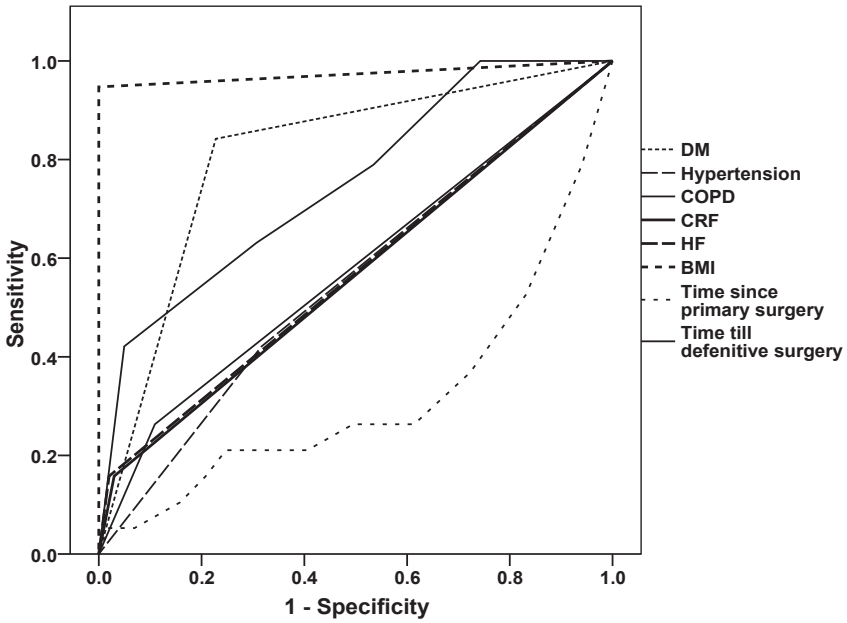

Fig. 6. ROC curve analysis of individual risk factors as predictors for mortality of DSWI patients.

myocardial revascularization. Sajja et al. [21] reported that several risk factors have been identified with DSWI, but a few are modifiable and strategies that reduce these modifiable risk factors include microbiological factors, appropriate antibiotic prophylaxis, tight glycemic control in line with surgical techniques which are associated with greater preservation of sternal blood supply and sternal closure and stability techniques. Bazylev et al. [22] documented that body mass index, duration of the operation, and performing re-sternotomy exerted a statistically significant influence on probability of development of DSWI.

5. Conclusion

In conclusion; DSWI was reported by a frequency of 1.54% after median sternotomy during open cardiac surgery. Management of DSWI is tedious, has prolonged hospital stay and is associated with high morbidity and mortality rates. Management of DSWI must be personalized according to findings on exploration of the sternal wound and flap coverage must be initiated only when the patient is bacteriologically free. Both PMF and/or VOF provided high acceptable success rate defined as survival free of DSWI recurrence.

Conflict of interest

None.

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